Department of Defense

High Level Architecture

Federation Development and Execution Process (FEDEP) Model

Version 1.0

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Table of Contents

List of Figures

FOREWORD

The formal definition of the Department of Defense High Level Architecture (HLA) comprises three main components: the HLA Rules, the HLA Interface Specification, and the HLA Object Model Template (OMT). These components are documented in the following reports:

- **HLA Rules V1.0**
- **HLA Interface Specification V1.0**
- **HLA Object Model Template V1.0**

This document, the HLA Federation Development and Execution Process (FEDEP) Model, is intended to identify and describe the sequence of activities necessary to construct HLA federations. This version of the HLA FEDEP Model has been heavily influenced by the experiences of the HLA protofederations, whose individual federation development processes have been coherently merged into a single, broadly applicable, high-level framework for federation development and execution. It is one element in the HLA Technical Library of information sources of general relevance to developing and executing HLA federations.

Currently, the "back-end," execution-specific elements of the FEDEP model are not explicitly discussed in this document. These elements will be incorporated in later versions of this document as the HLA protofederations continue to accrue experience in the execution phase of federation construction, and provide the feedback required to build a more complete end-to-end process model specification.

1. PURPOSE

The Department of Defense (DoD) Modeling and Simulation Master Plan [DOD95] calls for the establishment of a DoD-wide High Level Architecture (HLA) for modeling and simulation (M&S), applicable to a wide range of functional applications. The purpose of this architecture is to facilitate interoperability among simulations and promote reuse of simulations and their components.

A named set of simulations interacting via the services of the HLA Runtime Infrastructure (RTI) and in accordance with a common object model and a common HLA rule set is known as a HLA *federation*. The purpose of this document is to describe a high-level process by which HLA federations can be developed and executed to meet the needs of a federation sponsor. Since the intent of this document is to provide a somewhat general and broad framework for HLA federation construction, it is expected that different user communities may instantiate this process model for HLA applications in very different ways. Nonetheless, the guidelines and recommended practices described in this document are believed to be generally relevant to most HLA federations.

2. FEDEP MODEL

The Federation Development and Execution Process (FEDEP) Model describes a high-level functional framework for the development and execution of HLA federations. The intent of the FEDEP Model is to specify a set of recommended practices and guidelines for federation development and execution that federation developers can utilize as a framework to achieve the needs of their application. Although federations are free to deviate from the FEDEP Model as required, the guidelines described in this section will be sufficiently general to be applicable to most HLA federations.

The structure of the FEDEP model is shown in Figure 2-1. The shaded portions of this figure illustrate the baseline federation development processes that are described in this section. Components of the Modeling and Simulation Resource Repository (MSRR) that are used in the FEDEP Model will also be described. Processes intrinsic to the FEDEP Model that are not described in this section (unshaded areas of Figure 2-1) will be included at a later date.

2.1 Objectives Development

The purpose of Objectives Development is to 1) generate and fully document the federation sponsor's problem statement, and 2) specify a complete set of objectives to be addressed through instantiation and execution of the federation. The specification of the federation objectives is composed of the following three classes of information:

- A specification of the problem domain, including a formalized problem statement, high-level descriptions of critical systems of interest, and required Measures of Merit (MOMs). Coarse indications of required fidelity and resolution for simulated entities should also be included (input to Conceptual Analysis).
- A specification of operational context requirements, such as geographic conditions, environmental conditions, threat conditions, and required tactics (input to Scenario Development).
- A specification of management considerations, such as cost constraints, schedule constraints, facility constraints, and security requirements (input to Management Requirements).

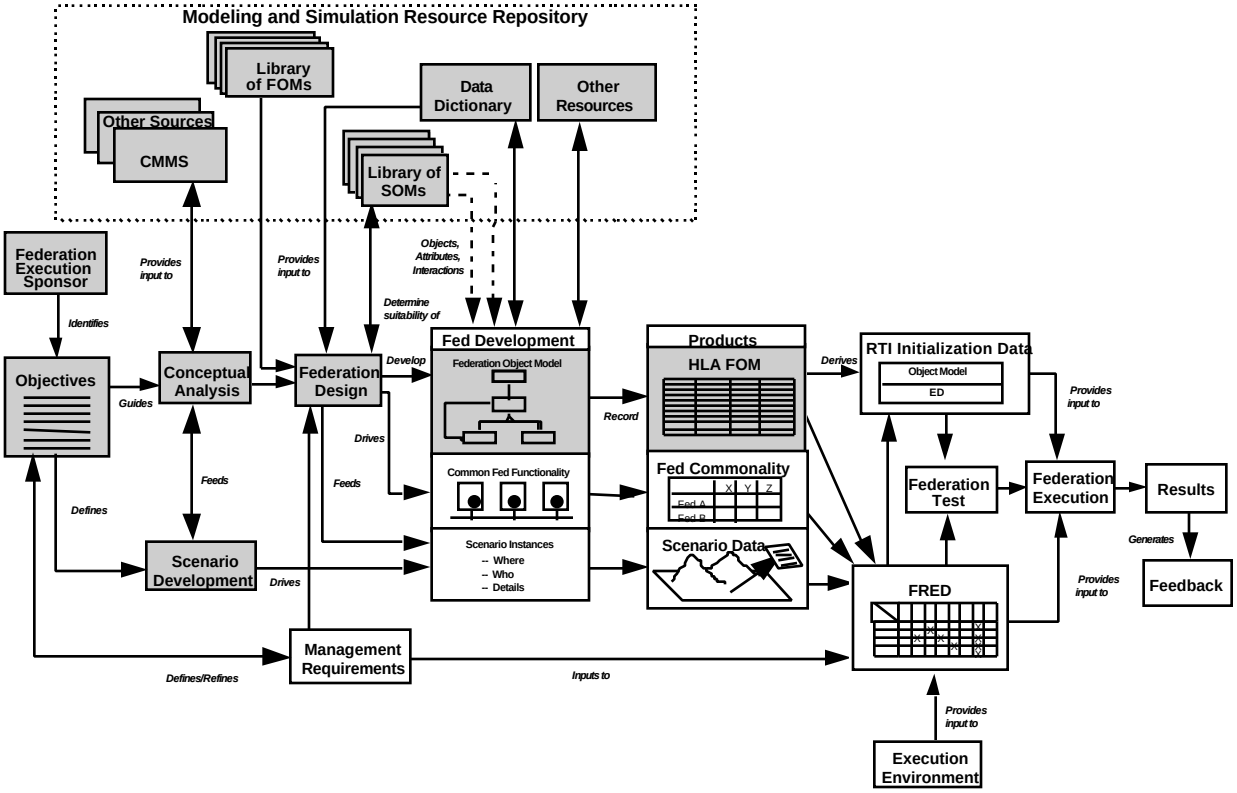

Figure 2-1. Federation Development and Execution Process Model

The statement of the Federation Objectives should include as much detail and specific information in each category as the sponsor can reasonably provide. Early and clear communication of intent between the federation sponsor and the ultimate developers of the federation is essential to minimizing rework in later stages of the Federation Development process.

To facilitate the use of automated tools during federation development, the specification of federation objectives should be stored electronically in a standard, well-documented format. This will allow electronic access to the sponsor's requirements for traceability during federation testing.

2.2 Scenario Development

The purpose of this phase is to develop a high-level specification of the federation scenario. The primary input to this activity is the operational context requirements stated in the Federation Objectives. The composition of a federation scenario includes an identification of the major entities that must be represented by the federation; a conceptual description of the capabilities, behavior, and relationships between these major entities over time; and a specification of relevant environmental conditions. Initial and termination conditions are also provided. Multiple scenarios

may be developed during this phase, depending on the needs of the federation. A single scenario may support multiple vignettes, where each vignette specifies a temporally ordered set of object activities and/or interactions.

The presentation style used during scenario construction is at the discretion of the federation developers. Textual scenario descriptions, event-trace diagrams, and graphical depictions of force laydowns and communication paths all represent effective means of conveying scenario information. Graphical scenario development tools can generally be configured to produce any of these presentation forms. Reuse of existing scenario databases may also facilitate the Scenario Development process.

2.3 Conceptual Analysis

The purpose of Conceptual Analysis is to develop a conceptual view of the objects and interactions that must be supported by the federation to achieve the sponsor's study objectives. This is known as a *federation conceptual model*. The primary activity in this phase is to decompose the conceptual description of the federation scenario into explicit components expressed as objects and interactions. External resources (e.g., CMMS) are expected to be useful in this process, and may necessitate refinements to the federation scenario description.

An important element of the Conceptual Analysis phase is the characterization of federation fidelity requirements. The basis for these requirements is the high-level, coarse indications of required fidelity included in the Federation Objectives. During Conceptual Analysis, this information is transformed and extended into specific fidelity requirements at the object/interaction level. The physical representation of these requirements may be structured and formatted so as to be directly mapable to individual Simulation Object Models (SOMs) during Federation Design. The Distributed Interactive Simulation (DIS) Fidelity Taxonomy represents a potential means for defining this structure.

Tool use is expected to be especially important during Conceptual Analysis. Besides the potential use of computer-aided software engineering tools to support development of the federation conceptual model, tools will be needed to ensure consistency between the federation conceptual model, the CMMS, the federation scenario, and the federation objectives. Specification of standard formats for each of these elements will increase the feasibility of automated tools that can perform these linkages, and thus facilitate the verification, validation, and accreditation (VV&A) process.

At the conclusion of this activity, the revised scenario description and list of required objects and interactions are presented to the federation sponsor for approval before the onset of

Federation Design. Revisions to the Federation Objectives may be defined and implemented as a result of this feedback.

2.4 Federation Design

The purpose of Federation Design is to establish the membership of the federation, and to develop the preparatory information required to support the development of HLA FOMs. The federation objectives, the federation scenario description, and the assembled listing of required objects and interactions (and associated fidelity requirements) provide the necessary foundation to begin Federation Design.

One of the first activities in this phase is to develop a mapping between the object and interaction classes specified in the federation conceptual model, and an appropriate set of object and interaction class names (and associated semantics) given in the MSRR's Data Dictionary. The Data Dictionary specifies a standard association between the names of object/interaction classes typically used in military simulations and a unique meaning. This mapping provides the necessary basis for building the Federation Object Model (FOM), and specifies the namespace for the classes that must be supported by the complete assemblage of federation participants.

The next major activity is to assess the possibility of reusing existing FOMs that have been previously developed for different but possibly similar applications. Libraries of existing FOMs may be accessed electronically (via automated tools) to facilitate this assessment. Most reuse opportunities are expected to be partial, meaning that subsets of existing FOMs can be extracted and combined to form a baseline FOM framework. Although the contents of the framework will be incomplete at this stage, the reuse and integration of "piece parts" from existing FOMs are generally preferable to starting from scratch.

The next major activity is to determine the suitability of individual simulation systems to become members of the federation. This will be primarily driven by the perceived ability of potential federation members to represent required objects and interactions at an appropriate level of fidelity. Certain management constraints (e.g., availability, security, facilities) may also influence selection of federation members. Automated browsing tools may be used to search electronic libraries of SOMs for candidate simulations, keyed to the standard namespace (from earlier mapping) of critical objects and interactions of interest. Reuse of existing FOMs may also facilitate the identification of potential federation members. Pointers to more detailed design information in selected SOMs will expedite the final selection process for federation membership.

The next major activity is to define a set of specific federation requirements to guide development of the FOM. These requirements are driven by the sponsor's statement of Federation

Objectives, and are generally developed collaboratively among all members of the federation. Examples of federation requirements which may affect FOM development include security requirements, publication/subscription requirements, and requirements for new software development. Other types of federation requirements that are not specific to FOM development (execution requirements, management requirements, etc.) will be described in a future "Management Requirements" section in this document. Automated tools may be used in this process to ensure traceability between the sponsor's original objectives and the more detailed federation requirements.

The last major activity in the Federation Design phase is to define a methodology for collaborative FOM development. This methodology defines the responsibilities of the individual federation members, and describes how the federation members will work together to produce a unified FOM. Meeting dates and milestones are defined in the overall FOM development schedule.

2.5 Federation Development

The purpose of Federation Development is to instantiate the methodology for collaborative FOM development defined during the Federation Design phase. The first major activity in this phase is to extract the classes of information from the SOM of each federation member that are believed to be relevant to the goals of the federation application. The pairings established between conceptual objects/interactions and individual SOMs during Federation Design provide the basis for this determination. The OMT formats used in the documentation of the SOMs should be preserved during the extraction process to facilitate FOM construction. Direct merging of SOM components into a FOM can be supported by automated tools.

The next major activity involves the integration of the material extracted from the individual SOMs into a coherent, unified framework for FOM construction. This primarily involves the resolution of semantic differences among the federates (via the Data Dictionary), and the development of federation object and interaction class structures (hierarchies) based on interest management considerations. The processes of establishing relationships (associations) among public object classes and developing the federation's FOM Lexicon may be initiated at this time. Software tools may be used in this phase to support FOM data entry and modification, and for local FOM data storage and retrieval. Computer-Assisted Software Engineering (CASE) tools may also be used as a means of FOM design and development.

Subsequent to (or in parallel with) the development of the federation object class structure, the set of object attributes currently supported by publishing federates are mapped against the requirements of subscribing federates to determine the need for problem resolution. Examples of

issues that may need to be addressed include the potential requirement for new attributes, incompatible security requirements, and insufficient or incompatible attribute update rates, datatypes, and/or fidelities. Resolution of these issues is primarily via negotiation among the federates, and may lead to additional requirements for new software development.

Finally, automated tools may be used to ensure the overall correctness of the object model. Tool features such as intra-FOM consistency checking, interface definition language syntax checking, and auto-generation of user-defined complex datatypes all facilitate the VV&A process and simplify the federation execution phase. Features to auto-generate RTI Initialization Data are also desirable.

Other related activities in this phase of Federation Development include the development of a specification on common federation services and resources (common databases, common algorithms, etc.), and the instantiation of the federation scenario via authoritative data sources.

2.6 HLA FOM Development

The purpose of this phase is to capture and record the information generated during FOM development in the Object Model Template (OMT) formats described in the HLA OMT and OMT Extensions Documents. The translation of this information may be manual, but is expected to be assisted by automated software tools in the future. The process of recording the FOM in OMT formats may be unnecessary if the OMT formats were used directly during FOM construction.

Acronyms

CASE	Computer-assisted Software Engineering
CMMS	Conceptual Models of the Mission Space
DIS	Distributed Interactive Simulation
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
FEDEP	Federation Development and Execution Process
FOM	Federation Object Model
HLA	High Level Architecture
M&S	Modeling & Simulation
MOM	Measure of Merit
MSRR	Modeling and Simulation Resource Repository
OMT	Object Model Template
RTI	Runtime Infrastructure
SOM	Simulation Object Model
VV&A	Verification, Validation, and Accreditation

References

[DOD95] Department of Defense, Under Secretary of Defense (Acquisition and Technology) (USD (A&T)), *DoD Modeling and Simulation (M&S) Master Plan*, Washington, DC, October 1995.

Comments

Comments on this document should be sent by electronic mail to the Defense Modeling and Simulation Office Object Model Template Working Group reflector (omtmplt@msis.dmso.mil). The subject line of the message should include the OMT section number referenced in the comment. The body of each submittal should include (1) the name and electronic mailing address of the person making the comment (separate from the mail header), (2) reference to the portion of this document that the comment addresses (by page, section number, and paragraph number), (3) a one-sentence summary of the comment and/or issue, (4) a brief description of the comment and/or issue, and (5) any suggested resolution or action to be taken.